cellular and PCS system design to statistically represent a typical user's behavior. This number is based on significant experimental testing.

Link budgets of SDARS systems often assume very low antenna noise temperatures (e.g. 125 degrees Kelvin claimed by Primosphere). It is clear that, to achieve low noise temperatures such as this, the SDARS antenna must avoid "looking" at the horizon and at warm buildings and other vehicles existing in urban and on-road environments. An additional isolation of 6 dB for an assumed 12 foot path from a trunk-mounted SDARS antenna to a pedestrian on the sidewalk may permit such a low antenna noise temperature. If the isolation were actually 0 dB, as claimed in the Primosphere Opposition, such a low antenna temperature would clearly not be possible, and the noise floor of the SDARS system would rise by at least 2 dB. For the discussions here, we will very conservatively assume no main-beam isolation, but accept a resulting rise in noise floor of 2 dB from Primosphere's figures.

The statistical polarization isolation between any two antennas with random polarization orientations is 3 dB; statistically, the transmitter radiates half its energy into a polarization orthogonal to the receiving antenna. While WCS and SDARS nominally use linear and circular polarizations, respectively, the random handset orientation and head effects in WCS and the beam-edge effects in SDARS lead to a high degree of randomness between their polarizations along the potential interference path. A 3 dB polarization factor correctly captures the typical isolation actually observed. It should be noted that polarization isolation cannot decrease from this average value by more than 3 dB, but can increase to much greater values for other random orientations.

The link budget calculations in the DigiVox contribution and supported by the January 27 letter from Stan Kay correctly indicate that, under their assumptions, a WCS handset will create a rise of 2 dB in the SDARS noise floor over a 12-foot radius. Making the 4 dB concession for SDARS main-beam/noise floor tradeoff described above, one concludes that, on average, **a WCS handset will create a rise of only 6 dB in the SDARS noise floor over a 12-foot radius.** Statistically speaking, outside this radius the rapidly increasing loss on the WCS-SDARS path will sharply limit the interference.

It is illustrative to compare this spatial description with that of other impairments faced by SDARS systems. In particular, consider the case of a single tree overhanging the roadway. Measurements by Vogel, Goldhirsh and others consistently yield attenuations averaging around 10 dB for a single tree, with significant variability in this number. The spatial extent of such an overhanging tree is certainly on the order of 25 feet or more. Since the detectability of a radio signal is determined by the ratio of its signal power to the interfering noise power, a rise in noise power is equivalent to a drop in signal power. Thus, one may conclude that **the effect to an SDARS receiver of a WCS handset is less than that produced by a single overhanging tree.**

Finally, one may evaluate the effect of such a localized impairment on an SDARS system. All SDARS systems have been designed with significant additional link margin (Primosphere has designed for 12 dB margin) to account for inevitable impairments such as trees, buildings, etc. SDARS systems will thus cope equally well with the localized interference from WCS transmitters. In the absence of other impairments, a WCS handset will not produce an SDARS outage. Because of this extreme localization, multiple simultaneous interference exposures from WCS are extremely unlikely. In the coverage area of a WCS base station employing PACS technology, only 7 simultaneous handsets can be supported. In a larger system, traffic blocking considerations limit this number to slightly over 4 simultaneous users per base station. The coverage area of such a base station would be on the order of 1000-2000 feet on a side. The existence of WCS handsets would, in effect, add only 4 trees to such a landscape.

Out of band noise generated by the PACS portables will be below the level to cause undue interference to SDARS

Primoshpere stated[7] that PPF/Digivox failed to recognize that specific roll-off recommendations are necessary for guard bands to be effective.

The WCS A&B bands where PACS could be used, do not abut the SDARS band. The issue of interest from a SDARS perspective is the amount of interference that a PACS system operating in the A and / or B WCS blocks will cause SDARS, not how the PACS modulated signal rolls off in other spectrum. The primary source of PACS portable unit interference into the SDARS band is noise produced by the final broadband amplifier. While this noise can not be practically removed by filtering[8] within the confines of a handset, it is at a level so as to not cause undue interference to SDARS as described in the section on link budgets.

Noise and Path Blockage are highly dependent on the operating environment; techniques used by SDARS to accommodate these variations in environment will also accommodate the small added interference from PACS portables.

DSBC in Comment III. 6 states that the PPF/Digivox assumptions concerning sky noise, filter insertion loss and post-LNA contributions to the noise floor of the SDARS receiver are opinion and that the proof of the actual noise floor is in the testing of yet to be built equipment. In addition, Primosphere has stated in Comment c. that "PPF/Digivox make incorrect assumptions about the margins available in the SDARS noise floor and the potential interference WCS will cause to SDARS."

[7] Opposition to the Petition for Expedited Reconsideration
[8] Lucent Technologies response to GN Dkt. 96-228/Wireless Communications Services, Jan 8, 1997

The opinion put forth by PPF/ Digivox is based on sound engineering judgment and well followed engineering practices. A 200K noise floor is a reasonable number for satellite communications using antennas with narrow beams pointed up into a cold sky, but not for antennas with significant gain in the direction of the horizon. DSBC's comment III 5, states, that a car mounted antenna has a vertically polarized gain at the horizon that is 2 dB below the circularly polarized gain in the direction of the desired transmitter. This antenna cannot realistically achieve a 200K noise floor; 290K is a more reasonable value[9]. In an urban environment the noise floor will be about 7 dB higher or 1400K[10].

"Primosphere also stated that the PPF/Digivox analysis of potential path blockage of the SDARS signal is incorrect." PPF/Digivox cited outages are possible of between 45 and 90%[11]. Primosphere identified three studies reporting that outages of duration over 3 seconds occur less than 2% of the time. Shadow fading is highly dependent on the environment. In urban environments, with tall building, SDARS users communicating with satellites positioned at elevation angles of between 35 and 65° will experience significantly higher than 2% outages due to path blockage. Techniques used to by SDARS operators to reduce the impact of outages, such as terrestrial repeaters, will also mitigate any impact from PACS portables. The additional margin added to combat the harsh propagation environment in urban environments will more than offset the interference caused by PACS portables in non-urban environments.

[9] "Antenna Engineering Handbook", 3rd edition, R. C. Johnson ed., McGraw Hill, 1993, pg. 29-10.
[10] "Technical Evaluation of Digital Audio Radio Systems Performance, Draft Report", January 1997, CEMA DAR Subcommittee.
[11] ibid

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Paul Zablocky joined Bellcore after working with Science Applications International Corporation (SAIC) and the Center for Naval Analysis (CNA), the Navy operations think tank. At SAIC, Dr. Zablocky was a radar systems engineer in the Technology Research Group where, among other things, he designed, modeled and analyzed antennas and their interactions with surrounding structures. Paul also served as a program manager for a low altitude missile exhaust plume measurement program. While at CNA, Paul analyzed the performance of multiple military data links and their interfaces. With Bellcore since 1995, Dr. Zablocky is a recognized expert on personal communications systems (PCS). His knowledge of CDMA and IS-41 has earned him recognition from several major telecommunication service providers and CDMA manufacturers. Currently, Dr. Zablocky is modeling electromagnetic propagation at PCS frequencies. Paul earned his Ph.D. in Electrical Engineering from the University of Pennsylvania in 1992, his MSEE in Electrical Engineering from the University of Central Florida, and his BS in Physics and BSEE from Fairleigh Dickinson University. Dr. Zablocky is a member of IEEE and Eta Kappa Nu, and participates in standards meetings of the T1S1 Mobility Management Application Protocol (MMAP).

Bob White is the Director of Wireless Loop Technology at Bellcore. He and his team are responsible for planning, engineering and implementing wireless local loop systems both domestically and internationally. His group performs intitial business analysis of alternative systems, investigates the areas to be covered, develops detailed netowrk and operations plans, provides engineering solutions for backhaul and interconnection, and supports the system deployment and testing.

Bob is president of the PACS Providers Forum, which is an industry group dedicated to advancing the PACS technology. The PACS Forum does this through industry education programs such as seminars, promotion campaigns, support for standards evolution, and regulatory activity. Its members include PACS system manufactures and supporting technology vendors, system software developers, system integrators, and wireless operators.

Previously, Bob led a software development group building new network capabilities and operations systems to provide integrated wireless voice and data services. He worked on the national CCS/SS7 implementation team where he lead the CCS interconnection service development effort. Bob has also had involvement in developing and evaluating CLASS, Multiswitch Business Group, Private Virtual Network and PCS Access Services.

Bob joined Bell Labs in 1980 and Bellcore in 1984. He has a Masters Degree in Mathematics from Arizona State University and a Ph.D. in Applied Mathematics from

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HAMILTON (Pete) ARNOLD received his Doctor of Engineering Science degree in Electrical Engineering from Columbia University in 1971. He joined the Radio Research Laboratory at Bell Laboratories, where he studied mobile and portable radio communications techniques and propagation, earth-satellite propagation, and advanced communications satellite system architectures. He joined the Radio Research Division at Bellcore at divestiture in 1984, where he currently manages a department conducting research on radio propagation, radio techniques, and systems analysis for portable and satellite communications. Dr. Arnold is a member of Sigma Xi and URSI Commission F. He received the Marconi SpA Prize and was elected an IEEE Fellow for his experimental research on earth-satellite propagation.

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